INDOOR AIR QUALITY ASSESSMENT

Joseph J. Hurley Elementary School
70 Worcester Street, South End
Boston, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program

August 2004

Background/Introduction

At the request of the Boston Public Schools' (BPS) Facilities Management Department (FMD), the Massachusetts Department of Public Health (MDPH), Center of Environmental Health's (CEH) Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the J.J. Hurley Elementary School (HES), 70 Worcester St, Boston, Massachusetts. Concerns about poor indoor air quality and health prompted the request.

On May 16, 2003, a visit to conduct an indoor air quality assessment was made to this school by Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA. Mr. Feeney was accompanied by Sharon Lee, Environmental Analyst, ER/IAQ, BEHA and Cathy Gallagher, Risk Communicator, Community Assessment Program (CAP), BEHA. During the assessment, BEHA staff was accompanied by Jeffrey Lane, Environmental Specialist, Planning and Engineering (PE), BPS, and Maria Carvalho, Environmental Supervisor, PE, BPS.

The HES is a two-story brick building constructed in 1961. The building underwent renovations for a new heating system in 1995. General classrooms are located on the second floor. The ground level is comprised of general classrooms, nurses' office, cafeteria, kitchen, teachers' room, auditorium, activity room and office space. Windows are openable throughout the building.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor Model 8551. Screening for total volatile organic compounds was conducted using a Thermo Environmental Instruments Inc., Model 580 Series, Photo Ionization Detector (PID). Air tests for ultra fine particulates (UFPs) were taken with the TSI, P-Trak ™ Ultrafine Particle Counter Model 8525. Outdoor carbon dioxide, temperature, relative humidity, ultra fine particulate, and TVOC measurements were taken as background readings for comparison to indoor levels. Instruments are calibrated as per manufacturer's specifications.

Results

The school has a student population of approximately 350 in grades K-5, as well as a staff of approximately 25. Tests were taken during normal operations at the school. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million of air (ppm) in 19 of 27 areas surveyed, indicating inadequate ventilation in some areas of the school. As indicated in Table 1, some of the classrooms had open windows during the assessment. Open windows can greatly reduce carbon dioxide levels.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (Picture 1). A univent draws air from outdoors through a fresh air intake located on the exterior walls of the building and returns air through an air intake located at the base of the unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents were found deactivated in many classrooms throughout the school (Picture 2). Obstructions to airflow, such as materials stored on top of univents or furniture located in front of univents, were also observed in a number of classrooms (Pictures 1 and 3). In order for univents to provide fresh air as designed, these units must remain "on" and allowed to operate while rooms are occupied. In addition, intakes must remain free of obstructions.

The mechanical exhaust ventilation system consists of wall-mounted exhaust vents connected to rooftop exhaust fans. In a number of classrooms, wall-mounted exhaust vents were blocked by desks, cabinets and other furniture (Picture 4). In other cases, wall vents were located behind classroom doors (Picture 5). As with the univents, in order for exhaust ventilation to function as designed, exhaust vents must remain free of obstructions.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

Temperature measurements ranged from 65^{o} F to 78^{o} F, which were close to the BEHA recommended comfort range in most classrooms. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. A number of temperature control complaints were expressed to BEHA staff. It is difficult to control temperature and maintain comfort in a building without operating the HVAC equipment as designed (e.g. univents deactivated/exhaust not functioning). In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 31 to 58 percent, close to the BEHA recommended comfort range in most areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A number of conditions conducive to microbial growth were noted at the HES. Water coolers are located in lounge areas. Standing water and debris were noted in catch basins (Picture 6). Stagnant water can provide a medium for bacterial and microbial growth. To prevent growth, catch basins should be emptied and cleaned regularly.

Plants in several classrooms were found on top of univents (Picture 1). Plants, soil and drip pans can serve as sources of mold growth, thus plants should be properly maintained. Over-watering of plants should be avoided, and drip pans should be inspected periodically for mold growth. Plants should also be located away from univents and ventilation sources to prevent aerosolization of dirt, pollen or mold.

Shrubbery, plants and fungi were growing in close proximity to the foundation walls (Pictures 7a and 7b). Fungi growth is an indication of high moisture content, and that some portions of the landscape have experienced water accumulation. Roots growing against the exterior walls can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level. Over time, this process can undermine the integrity of the building envelope and provide a means of water entry into the building through capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001).

Plants were also noted to be growing beneath univent fresh air intakes along the perimeter of the building (Picture 8). Care should be taken to ensure that fresh air intakes remain clear of obstructions (e.g. snow, shrubbery) to avoid the entrainment of dirt, moisture and or pollen.

The school has a ceiling tile system where tiles are glued directly to the ceiling decking. Ceiling tiles in a number of classrooms have sustained water damage. Replacement of these ceiling tiles is difficult, since their removal appears to necessitate the destruction of the tile, which can result in the aerosolization of particulates. Water-damaged ceiling tiles may provide media for mold growth and should be replaced after a water leak is discovered and repaired.

An inspection of the crawlspaces revealed visible mold growth on the soil floor (Picture 9). Standing water was also noted in the crawlspace. An open pipe was seen protruding from the standing water pool (Picture 10). The purpose of the pipe could not be determined. If it were a sewer pipe, sewer gas could penetrate into this section of the crawlspace, particularly during rainstorms. Sewer gas contains different substances that can be eye, nose and respiratory system irritants.

Several pathways exist for crawlspace air to migrate into occupied areas. An exhaust vent for the crawlspace is located directly below a fresh air intake of a classroom univent (Picture 11). The configuration results in the entrainment of crawlspace exhaust into the classroom. As a result, odors and/or particulates associated with standing water and visible mold growth in the crawlspace can be introduced into the classroom.

Furthermore, the nurses' office is located above portions of the crawlspace. The radiator system was examined, and holes in the floor around radiator pipes were observed. These gaps allow for movement of crawlspace air into the office. Similar pathways for crawlspace air to migrate into occupied space may exist in other rooms with similar radiator installations.

Lastly, a seam was located along the wall outside of classroom 107 (Picture 12). An abandoned vent was also noted in a stairwell (Picture 13). These breaches can serve as pathways for air, odors and particulates to be drawn into occupied from exterior wall cavities and the crawlspace. A seam was also noted between two adjoining exterior walls (Picture 14). Under driving rain conditions, water can penetrate the building through the seam.

Other Concerns

Several other conditions that can affect indoor air quality were noted during the assessment. A noticeable, slightly irritating odor was detected upon BEHA staff entry into the building. This odor was traced to a univent that had melted crayons inside the air diffuser, as well as in vents connected to the axial fans (Picture 15a and 15b). Univents in this building are designed to provide heated fresh air during cold weather. In this instance, the operation of the univent heats and melts crayons to produce fumes. The odors are then distributed into the classroom and adjacent hallway. The presence of crayon residue inside univents provides a reservoir of materials that, if not remediated, will continue to produce irritating fumes. The Material Safety Data Sheet for Crayola® crayons indicates that if this product were melted, the procedure should be conducted in a *well-ventilated area.* (Binney & Smith, 2002). "Overheating wax crayons during melting or ironing may release irritating fumes" (Binney & Smith, 2002).

The univent filters are of a type that provides minimal filtration of respirable dusts. Univents are normally equipped with filters that strain particulates from airflow. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by univents due to increased resistance, or pressure drop. Prior to any increase of filtration, a ventilation engineer should evaluate each univent to ascertain whether it can maintain function with more efficient filters. Univent filters were examined in a number of classrooms. Univents were equipped with two fibrous mesh filters in cardboard frames. Filters were noted to have accumulated debris (Picture 16). A debris-saturated filter can obstruct airflow and may serve as a reservoir of particulates that can be re-aerosolized and distributed to occupied areas.

According to school officials, the HES has a history of rodent problems. Rodent infestation can result in indoor air quality related symptoms due to materials in their wastes. Mouse urine is known to contain a protein that is a known sensitizer (US EPA, 1992). A sensitizer is a material that can produce symptoms in exposed individuals and can cause running nose or skin rashes in sensitive individuals. Since particulates can be drawn into the air stream, univents with filters that provide minimal respirable dust filtration can serve to distribute these particulates. It is important that proper filters be installed in univents to reduce this potential problem. A three-step approach is necessary to eliminate rodent infestation:

- remove rodents;
- clean waste products from the interior of the building; and
- reduce/eliminate pathways/food sources that are attracting rodents.

To eliminate exposure to allergens, rodents must be removed from the building. Please note that removal, even after cleaning, may not provide immediate relief since allergens can exist in the interior for several months after rodents are eliminated (Burge, 1995). A combination of cleaning and increase in ventilation and filtration should serve to reduce rodent associated allergens once the infestation is eliminated.

In efforts to eliminate pest problems, rodenticide was placed in univent chambers (Picture 17). The rodenticide was not in bait trays. Instead, the bait was placed in the univent chamber near an uninsulated pipe, which is connected to the heating coil. No melted rodenticide pellets were noted; however, an inquiry with the contractor concerning temperature stability of this product should be explored. If these matrices are thermally unstable at temperatures maintained by the heating pipes, the wax can melt and potentially produce fumes. Airflow through the univent could subsequently aerosolize rodenticide components.

Use of rodenticides alone cannot prevent pest and rodent problems. Food is an attractant to pests and rodents. Food was found in open areas (Picture 18). In addition, food sacks found in the basement were reused to store rock salt (Picture 19). As previously discussed, proper food storage is an integral component in maintaining sanitary conditions. Reuse of food containers is not recommended, since food residue adhering to the surface may serve to attract pests.

A number of classrooms contained upholstered furniture. Upholstered furniture is covered with fabric that comes in contact with human skin. This type of contact can leave oils, perspiration, hair and skin cells. Dust mites feed upon human skin cells and excrete waste products that contain allergens. In addition, if relative humidity levels increase above 60 percent, dust mites tend to proliferate (US EPA, 1992). In order to remove dust mites and other pollutants, frequent vacuuming of upholstered furniture is recommended (Berry, 1994). It is also recommended that if upholstered furniture were present in schools, it should be professionally cleaned on an annual basis or every six months if dusty conditions exist outdoors (IICR, 2000).

Also of note was the amount of materials stored inside classrooms (Picture 20). In classrooms throughout the school, items were seen on windowsills, tabletops, counters, bookcases and desks. The large amount of items stored in classrooms provides a means for dusts, dirt and other potential respiratory irritants to accumulate. Many of the items, (e.g. papers, folders, boxes) make it difficult for custodial staff to clean. A number of exhaust vents in classrooms were also noted with accumulated dust (Picture 21). Back drafts can result in re-aerosolization of accumulated dust particles. Dust can be irritating to the eyes, nose and respiratory tract.

A number of insect bodies were noted on top of a univent and on windowsills. Insect parts can dry and become aerosolized and may serve as a source of allergenic material for sensitive individuals. The most likely route for insect penetration into the building is through spaces around window frames. The reduction/elimination of pathways into the building should be the first step taken to prevent an insect infestation.

Cleaning products and other chemicals were found in floor level cabinets and on counter tops in several classrooms. In one instance, cleaning products were found in a first –aid cabinet (Picture 22). Cleaning products contain chemicals, such as bleach or ammonia-related compounds, that can be irritating to the eyes, nose and throat. These items should be stored properly and out of the reach of students.

Accumulated chalk dust was noted in some classrooms. Chalk dust is a fine particulate, which is an eye and respiratory irritant that can be easily aerosolized. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Photocopiers also produce VOCs. In addition, photocopiers can produce ozone, particularly if the equipment is older and in frequent use. VOCs and ozone are respiratory irritants (Schmidt Etkin, 1992). Photocopiers were located in the main office; however, no local exhaust ventilation for the photocopiers exists. At least one printer (Risograph®) uses a liquid toner, which can produce odors and particulates that are irritating to eyes and the respiratory system.

Bathrooms on each floor are equipped with floor drains. Drains did not appear to have recently drained water, which can lead to dry traps. In addition, a floor drain in the first floor girls' bathroom was blocked with debris because it was missing a drain cover (Picture 23). A trap forms an airtight seal when water is poured down the drain. A dry trap can allow for sewer gas to back up into the building. Sewer gas can be irritating to the eyes, nose and throat.

Health Concerns

In February 2003, the BEHA received a written request from the Boston Public Schools facilities management department to further investigate health concerns, including cancer, among staff at the HES. The request to the BEHA also included a letter sent to the Boston City Council in March 2002 from a staff person at the HES. Specific concerns in this letter focused on reports of a large number of cancer diagnoses among current and former employees of the HES and whether this may represent an atypical pattern or possibly be related to a common environmental factor within the building. Although information on the types of cancers diagnosed among employees of the HES was included in the letter, specific information about each individual diagnosed with cancer (i.e., name, date of diagnosis, age at diagnosis, dates of employment at the school) was not provided.

In May 2003, staff from the Community Assessment Program (CAP), a division within the BEHA, accompanied staff from the BEHA's ER/IAQ Program on an indoor air inspection of the HES. Investigations of suspected disease clusters conducted by staff in the CAP are very detailed and take a number of individual factors into account as part of the overall assessment. Therefore, in order to further investigate concerns about cancer diagnoses among school employees, CAP staff instructed employees of the HES at the time of the ER/IAQ inspection to submit a written request to the BEHA with specific information on each individual diagnosed with cancer including primary site of cancer, approximate age and date of diagnosis, and approximate dates of employment at the HES.

As of May 2004, the BEHA had not received the requested information on employees with a reported cancer diagnosis. Because information on employees was incomplete, ER/IAQ staff contacted an employee of the HES in May 2004 to obtain additional information on individuals reported to the BEHA with a cancer diagnosis. Through personal communication with the HES staff member, the BEHA learned that employees of the HES did not wish to provide further information on staff diagnosed with cancer until they had received the IAQ assessment of the building. Therefore, further evaluation of cancer diagnoses among staff at the school cannot be conducted at this time. If more specific information is provided, BEHA staff will provide further assessment.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Operate both supply and exhaust ventilation continuously during periods of school occupancy independent of classroom thermostat control.
2. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Operate univents while classrooms are occupied. To increase airflow, set univent controls to “high”. Consider

consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.

3. Remove all blockages to univents and exhaust vents.
4. Consider having ventilation systems re-balanced every five years by an HVAC engineering firm.
5. Use the principles of integrated pest management (IPM) to rid the building of pest. Activities that can be used to eliminate pest infestation may include the following activities.
   a) Rinse out recycled food containers. Seal recycled containers in a tight fitting lid to prevent rodent access.
   b) Remove non-food items that rodents are consuming.
   c) Store foods in tight fitting containers.
   d) Avoid eating at work stations. In areas were food is consumed, periodic vacuuming to remove crumbs is recommended.
   e) Regularly clean crumbs and other food residues from toasters, toaster ovens, microwave ovens coffee pots and other food preparation equipment;
   f) Examine each room and the exterior walls of the building for means of rodent egress and seal appropriately. Holes as small as ¼ inch is enough space for rodents to enter. If doors do not seal at the bottom, install weather stripping as a barrier.
   g) Reduce harborages (e.g. cardboard boxes) to prevent rodent residency.

   A copy of the IPM Guide can be obtained at the following Internet address:

   http://www.state.ma.us/dfa/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf

6. Remove crayon residues from univents. Prevent students from inserting crayons into univents.
7. Adopt scrupulous cleaning practices. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
8. Clean catch basins for water coolers periodically to prevent microbial growth.
9. Move plants away from univents in classrooms. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary. Consider reducing the number of plants.
10. Remove plants and weeds that are growing along building foundation and below fresh air intakes.
11. Replace/repair water-stained ceiling tiles and building materials. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as necessary.
12. Consider the following actions as a means to prevent moisture penetration into the crawlspace:

a) Install gutters and downspouts to direct rainwater at least five feet away from the foundation.

b) Remove foliage to no less than five feet from the foundation.

c) Improve the grading of the ground away from the foundation at a rate of 6 inches per every 10 feet (Lstiburek & Brennan, 2001).

d) Install a water impermeable layer on ground surface (clay cap) to prevent water saturation of ground near foundation (Lstiburek & Brennan, 2001).

13. Identify the purpose of the pipe in the crawlspace. Repair, cap or remove as needed.

14. Seal all utility holes, wall cracks and any other possible pathways to prevent the egress of materials into the school.

15. Consider having exterior brick re-pointed and waterproofed to prevent water intrusion.

16. Consider having upholstered furniture cleaned professionally on an annual basis.

17. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

18. Store cleaning products properly and out of reach of students.

19. Clean chalkboards and trays regularly to avoid the build-up of excessive chalk dust.

20. Install local exhaust ventilation in the main office to prevent build up of VOCs and excess heat produced by photocopiers.

21. Ensure drain covers are installed on all floor drains and pour water down drains regularly to prevent dry traps and associated odors.

22. Consider adopting the US EPA document, *Tools for Schools* (US EPA, 2000), as a means to maintaining a good indoor air quality environment in the building. This document is available at http://www.epa.gov/iaq/schools/index.html.

23. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are available at the MDPH's website: http://www.state.ma.us/dph/beha/iaq/iaqhoFtme.htm.

References

ASHRAE. 1992. Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 52.1-1992.

Berry, M.A. 1994. *Protecting the Built Environment: Cleaning for Health.* Michael A. Berry, Chapel Hill, NC.

Binney and Smith. 2002. Material Safety Data Sheet, Crayola Crayon, 2nd Ed. Binney and Smith, Easton, PA.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

Burge, H.A. 1995. *Bioaerosols*. Lewis Publishing Company, Boca Raton, FL.

IICR. 2000. IICR S001 Reference Guideline for Professional On-Location Cleaning of Textile Floor Covering Materials Institute of Inspection, Cleaning and Restoration Certification. Institute of Inspection Cleaning and Restoration, Vancouver, WA.

Lstiburek, J. & Brennan, T. 2001. Read This Before You Design, Build or Renovate. Building Science Corporation, Westford, MA. U.S. Department of Housing and Urban Development, Region I, Boston, MA

MEHRC. 1997. Indoor Air Quality for HVAC Operators & Contractors Workbook. MidAtlantic Environmental Hygiene Resource Center, Philadelphia, PA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0.

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning

Thornburg, D. 2000. Filter Selection: a Standard Solution. *Engineering Systems* 17:6 pp. 74-80.

US EPA. 1992. Indoor Biological Pollutants. US Environmental Protection Agency, Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Research Triangle Park, NC. ECAO-R-0315. January 1992.

US EPA. 2000. Tools for Schools. Office of Air and Radiation, Office of Radiation and Indoor Air, Indoor Environments Division (6609J). EPA 402-K-95-001, Second Edition. http://www.epa.gov/iaq/schools/tools4s2.html

Picture 1

Univent, note blockage by trash barrel and location of plants

Picture 2

Univent turned 'off'

Picture 3

Blocked univent

Picture 4

Blocked exhaust vent

Picture 5

Exhaust vent located behind door

Picture 6

Water cooler on plastic cover with standing water and debris

Picture 7a

Plant growth against building foundation

Picture 7b

Fungi growth around school perimeter

Picture 8

Plants located in front of univent fresh air intake

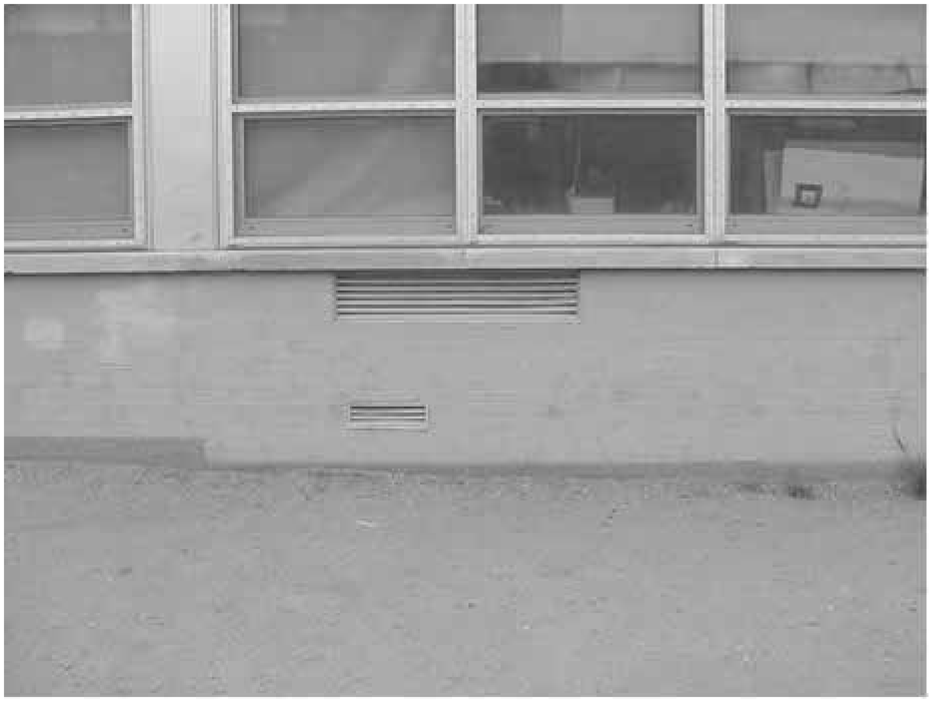
Picture 9

Mold growth on crawlspace floor

Picture 10

Unsealed pipe protruding from crawlspace floor

Picture 11



Crawlspace exhaust located below univent fresh air intake

Picture 12

Seam in wall outside classroom 107

Picture 13

Abandoned vent in stairwell

Picture 14

Seam between two adjoining walls in building exterior

Picture 15a

Crayons in univent

Picture 15b

Melted crayon wax in univent

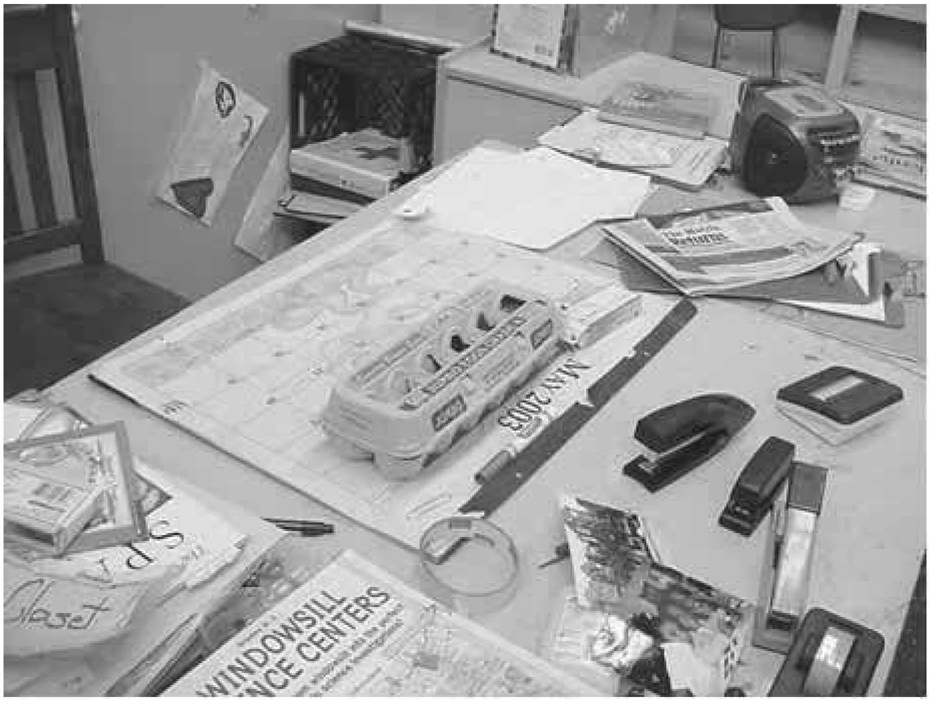
Picture 16

Accumulated debris on univent filter

Picture 17

Rodenticide near heating pipe

Picture 18



Food stored in open area

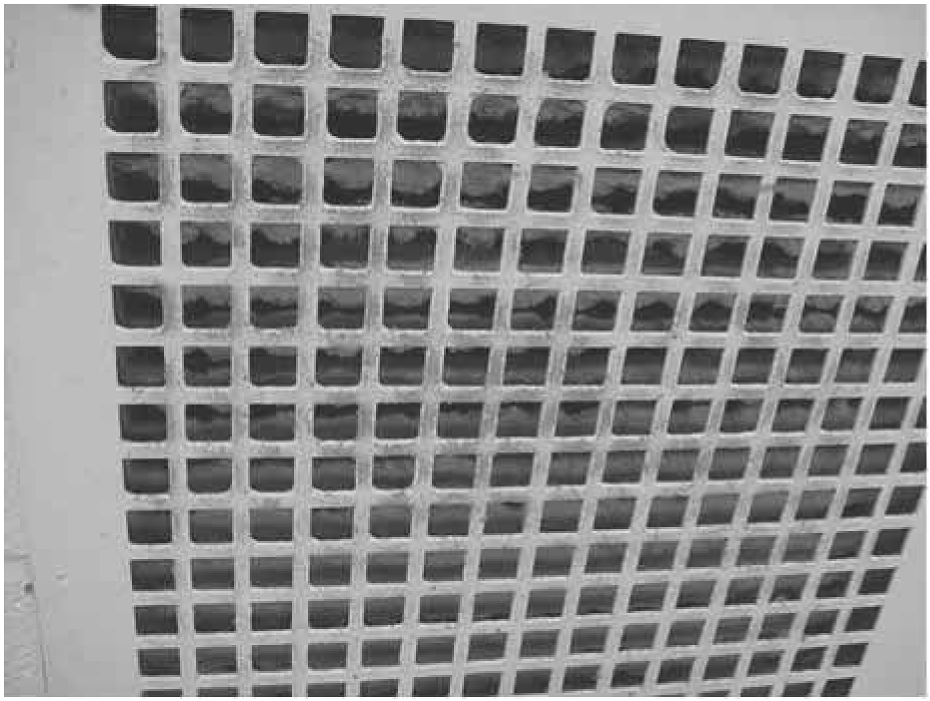
Picture 19

Rock salt stored in cake donut mix sack

Picture 20

Organization and storage of materials in classroom

Picture 21



Accumulated dust on exhaust vent

Picture 22

Cleaning agents stored in first-aid cabinet

Picture 23

Drain with missing drain cover in the first floor girls' bathroom

TABLE 1

Indoor Air Test Results –J. J. Hurley Elementary School, Boston, MA May 16, 2003

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background Outdoor	468	58	34					Hot and sunny Scattered clouds, light breeze
After School Room	527	45	42	3	Y	N	N	Upholstered furniture; food; plants; Standing water under water cooler
Room 201	706	74	34	10	Y	Y	Y	Supply (2): 1 on, 1 off
Room 202	532	73	32	11	Y	Y	Y	Exhaust blocked by desk; supply off and switch broken; water damage
Room 203	1085	74	35	21	Y	Y	Y	Supply off – switch broken; Exhaust blocked by desk
Room 204	559	70	33	0	Y	Y	Y	Supply off; DEM; Exhaust blocked by table
Room 101	981	74	36	19	Y	Y	Y	Supply off; Exhaust blocked by poster; plants over UV; DEM; 2 AT

*** ppm = parts per million parts of air**
AT = ajar tiles
CD = chalk dust
CT = water-damaged ceiling tiles
DEM = dry erase materials
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

Indoor Air Test Results –J. J. Hurley Elementary School, Boston, MA   May 16, 2003

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Room 102	567	73	33	0	Y	Y	Y	Supply off Crayon odor
Room 103	511	74	34	5	Y	Y	Y	Exhaust blocked by poster Door open
Room 104	488	69	32	6	Y	Y	Y	10 CT Door open
Room 125	874	74	40	1	Y	N	N	
Auditorium	577	71	40	1	Y	Y	Y	
Cafeteria	1825	72	40	1				
Kindergarten Room 113	540	68	38	1	Y	Y	Y	Supply off, blocked Door open, plants
Kindergarten Room 114	640	66	39	21	Y	Y	Y	Supply off and blocked; exhaust blocked; Windows open

*** ppm = parts per million parts of air**
AT = ajar tiles
CD = chalk dust
CT = water-damaged ceiling tiles
DEM = dry erase materials
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

Indoor Air Test Results –J. J. Hurley Elementary School, Boston, MA **May 16, 2003**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Room 205	551	73	31	0	Y	Y	Y	Door and window open; CD; Cleaner storage; materials on UV
Room 206	525	74	32	0	Y	Y	Y	Windows and door open; CD; Supply blocked
Room 207	568	75	33	1	Y	Y	Y	Supply blocked; CD; DEM
Room 208	575	75	32	0	Y	Y	Y	Supply blocked; strong, musty odor; cleaners storage; DEM; 4CT
Room 209	750	75	32	0	Y	Y	Y	Plant on UV; DEM; CD; 25 computers; cleaners
Room 105A	780	73	34	3	Y	Y	N	Supply off; CD; UV hot; passive exhaust vent into computer server
Room 105B	505	74	32	0	Y	Y	Y	Supply off; exhaust off and vent closed; personal fan; CD; cleaner

*** ppm = parts per million parts of air**
AT = ajar tiles
CD = chalk dust
CT = water-damaged ceiling tiles
DEM = dry erase materials
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

Indoor Air Test Results –J. J. Hurley Elementary School, Boston, MA May 16, 2003

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
								storage
Room 106	538	71	32	20	Y	Y	Y	Window open; supply and exhaust blocked; dead insects
Room 107	810	78	38	18	Y	Y	Y	Supply and exhaust blocked; DEM; personal fan; cleaner storage; CD
Room 108	891	75	35	17	Y	Y	Y	Supply and exhaust blocked; plants; clutter; cleaner storage; CD; DEM
Office	691	74	32	0	Y	Y	N	Window open; personal fan; Risograph; copiers
Room 112	840	73	37	18	Y	Y	Y	Supply and exhaust blocked; DEM; bathrooms with passive vents; CD
Nurses' Office	1356	67	58	0	Y			Holes in floor; garden outside of window

*** ppm = parts per million parts of air**
AT = ajar tiles
CD = chalk dust
CT = water-damaged ceiling tiles
DEM = dry erase materials
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

Indoor Air Test Results –J. J. Hurley Elementary School, Boston, MA May 16, 2003

*** ppm = parts per million parts of air**
AT = ajar tiles
CD = chalk dust
CT = water-damaged ceiling tiles
DEM = dry erase materials
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Particulate and TVOCs Testing
JJ Hurley Elementary School, Boston, MA –January 9, 2003

Area	Location in Area	Number of Ultrafine Particulates Particles per cc of air (in thousands)[a]	Total Volative Organic Compounds (*ppm)
Outside (Background)	SW corner of building	23	0
	W corner of building	39	0
	NW corner of building	37	0
	NE corner of building	37	0
Room 202	Center of room	22	0
Room 204	Center of room	16	0
Room 102	Center of room	29	0
Room 114 (kindergarten)	Center of room	16	0
Room 205	Center of room	26	0
Room 105B	Center of room	29	0
Nurses' Office	Center of room	18	0

* ppm = parts per million
[a] Device measures total airborne particulates of a diameter 0.02-1 micrometers